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Cancel claims 2 - 4 and 6 - 9, without prejudice.

Claim 10, line 1, change "4" to --1--.

Claim 11, line 1, change "4" to --1--.

Claim 12, line 1, change "4" to --1--.

Cancel claims 13 - 22, without prejudice.

Add claim 32, as follows:

92 Sub. Co. Claim 32. The cathodic material as set forth in claim 1 wherein said lithium ion conductor is $\text{LiCo}_x\text{Ni}_{1-x}\text{O}_2$ and wherein $x > 0$ and $x > y$.

REMARKS

Claims 1 - 3, 5 - 9, 13 - 15, 17 - 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fey 5,486,346.

Claims 2 - 4, claims 6 - 9 and claims 13 - 22 have been withdrawn, without prejudice.

Claim 1 has been rewritten to incorporate the lithiated transition metal oxide core material recited previously in claim 4. Claim 1 accordingly is now limited to a lithiated transition metal oxide core consisting of lithium nickel dioxide or lithium nickel cobalt dioxide having the formula $\text{LiNi}_y\text{Co}_y\text{O}_2$ wherein $y > 0$, or a mixture thereof.

Antecedent support for the core compositions is provided on page 6, lines 15 - 18 of the specification.

Dependent claim 5 recites a lithium ion conductor which is a lithiated metal oxide or lithiated mixed metal oxide wherein said metal is selected from the group consisting of Groups

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IIIb, IVB, VB, VIB, VIIB, and VIII of the Periodic Table, aluminium and boron, and claim 10 recites a lithium ion conductor selected from the group consisting of lithium cobalt dioxide (LiCoO_2), lithium cobalt nickel oxide ($\text{LiCo}_x\text{Ni}_{1-x}\text{O}_2$), lithium aluminum dioxide (LiAlO_2) and lithium aluminium nickel oxide ($\text{LiAl}_x\text{Ni}_{1-x}\text{O}_2$), and mixtures thereof, and wherein $x > y$.

Claims 11 and 12 dependent on claim 1, recite $\text{LiCo}_x\text{Ni}_{1-x}\text{O}_2$ as a lithium ion conductor having thickness ranges and relative parameters for the "x" and "y" functions.

New claim 32 has been added, wherein the lithium ion conductor is $\text{LiCo}_x\text{Ni}_{1-x}\text{O}_2$ and wherein $x > 0$ and $x > y$. Antecedent support is provided on page 13, lines 8 - 11 of the specification.

It is believed claim 1 as amended and claims 5, 10, 11, 12 and 32 dependent thereon are clearly patentably distinguished over Fey for the following reasons.

Applicant's claimed electrode material contains a lithiated transition metal oxide which functions as a core and a lithium ion conductor in contact with the core to stabilize said core. The lithium ion conductor must be more stable than the core and different from the core in order to stabilize the core.

In order to achieve the above targets, the process of the invention includes coating the starting materials (e.g. $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and LiNO_3) of the lithium ion conductor onto the particle surface of lithium transition metal oxide core before a high temperature reaction to allow the lithium ion conductor to grow on the surface of the core. There are two phases in the final product; one is the core and the other is the lithium ion conductor. In order to produce this product material, the following conditions must be met:

- (1) The lithiated transition metal oxide core functional as an intercalation cathode is synthesized first before the lithium ion conductor is formed on the surface of the core from the conductor starting materials;
- (2) The starting materials used for the synthesis of the lithium ion conductor are dissolved in water and then the lithiated transition metal oxide core is mixed with

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the solution to form a slurry. The slurry is stirred and heated to remove water. The starting materials precipitate slowly and coat on the particle surfaces of the lithiated transition metal oxide core during the water vaporization, to become the lithium ion conductor on the surface of the core after heating;

- (3) The mixture from step (2) is heated at high temperature (for example 750°C) to form the lithium ion conductor on the surface of the core;
- (4) The starting materials used for the synthesis of the lithium ion conductor are only small fractions of the core material by mole ratio;
- (5) The lithium ion conductor must be more stable than the core; and
- (6) The lithiated transition metal oxide core must have a higher capacity than the lithium ion conductor.

All the six conditions are essential. Conditions (1) - (3) are related to how to synthesize the materials with a core and an outer layer structure. Conditions (4) - (6) are related to selection of materials to obtain stable and high capacity cathode materials.

The condition (1) is needed to ensure that the core surface of lithiated transition metal oxide is available when the lithium ion conductor is formed. The condition (2) is needed to ensure that the starting materials (e.g. $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, LiNO_3) of the lithium ion conductor are coated on the surface of the lithiated transition metal oxide core. The lithium ion conductor can then form on the surface of the lithiated transition metal oxide core at the high temperature of condition (3).

The condition (4) is needed because it is applicant's target to synthesize high capacity materials, the capacity being mainly attributed to the core material, and not the lithium ion conductor. Therefore the amount of lithium ion conductor is small compared to the amount of the core material. The condition (5) is to ensure that the lithium ion conductor is functional to protect the core. The condition (6) is to ensure that the electrode material made has a high capacity.

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With reference to applicant's Examples and to Figures 1 - 5, particularly Sample 2, it will be noted that guidelines (1) - (6) above are followed.

Sample 2 (example 2, page 17) is made with LiNiO_2 as a core which is synthesized (condition (1)). The starting materials ($\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and LiNO_3) of the lithium ion conductor were both dissolved in water and did not react with each other in water to precipitate. The slurry was stirred and heated to remove water to allow the starting materials to precipitate slowly and to coat onto the particle surface of LiNiO_2 during the water vaporization (condition (2)). The material was then heated at 750°C (condition (3)). The LiNiO_2 core content in sample 2 was significantly higher than the $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ content because the mole ratio of $\text{LiNiO}:\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ equalled about 1.00 : 0.033 (condition (4)). Since $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ with more cobalt is more stable (W. Li, et al. J. Electrochem. Soc. vol. 144, 2773 (1997) in Figure 3) and sample 2 has more cobalt on the surface than in the core (example 12), the lithium ion conductor on the surface is more stable than the core (condition 5). Furthermore, $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ with less cobalt has higher capacity (W. Li, et al. J. Electrochem. Soc. vol. 144, 2773 (1997) in Table I) and since sample 2 has less cobalt in the core, sample 2 has higher capacity from the core (condition 6). The two phase structure of lithium ion conductor $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ on the surface and the LiNiO_2 core was confirmed by both x-ray (example 8) and Auger analysis (example 12).

Fey disclosed two methods to synthesize LiNiVO_4 and LiCoVO_4 ; one being a solid phase sintering method and the other an aqueous-phase solution method.

In the solid-phase sintering method, LiNiO_2 or LiCoO_2 is synthesized first (example 1 - 8, example 11; col. 2, lines 35 - 40 of Fey). In that applicant requires that the LiCoO_2 which will be used as the lithium ion conductor be formed later, condition (1) is violated for the LiCoO_2 embodiments. Furthermore, it is not known if lithium vanadium oxide is more stable or less stable than LiNiO_2 or LiCoO_2 , so condition (1) is not proved.

Examples 1 - 8 (col. 5, line 45, to col. 6, line 10 of Fey) show that Li_xNiO_2 and V_2O_3 were ground and homogeneously mixed. Since it is a homogeneous solid state mixture, the starting materials do not coat on the surface of the lithium transition metal oxides. Therefore the process

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violates condition (2). Since the V and LiNiO_2 mole ratio is 1:1, condition (4) is violated. Since Fey does not describe the stability of LiNiVO_4 and LiCoVO_4 related to other materials, there are no guidelines of which materials should be selected as the core and which materials should be selected as the lithium ion conductor. Therefore conditions (5) and (6) are not provided.

In the aqueous-phase solution method, there are no lithium transition metal oxides before the reaction, so condition (1) is violated. Although $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{LiOH} \cdot \text{H}_2\text{O}$ can be dissolved in water, both $\text{Co}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ and $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ can react with $\text{LiOH} \cdot \text{H}_2\text{O}$ to precipitate and the V_2O_5 is added after the precipitation (col. 6, lines 13 - 21; col. 6, line 65 to col. 7, line 1 of Fey). Accordingly, there is no coating step in which the starting material can precipitate slowly to coat on the surface of a lithium transition metal oxide core during water vaporization. Condition (2) thus is violated. The mole ratio of Co:V is 1.0:1.0, and therefore condition (4) is violated. Since Fey does not describe the stability of LiNiVO_4 and LiCoVO_4 relative to other materials, there are no guidelines as to which materials should be in the core and which materials should be the lithium ion conductor. Therefore conditions (5) and (6) are not provided.

Fey's process does not include a number of essential process steps required in the present application. As a result of these differences, the product from the Fey process is substantially different than applicant's product. In the solid-phase sintering method (examples 1 - 9, 11 of Fey) all the samples contain NiO (col. 6, line 6; col. 7, lines 39 - 40 of Fey) which is neither lithium transition metal oxide nor lithium metal oxide. In other words, NiO cannot function as an intercalation core or lithium ion conductor. Furthermore Co_3O_4 , which is neither a lithium intercalation core nor a lithium ion conductor is present (col. 6, lines 48 - 50 of Fey). If NiO or Co_3O_4 is in an outer layer of the particle, the particle will not function for applicant's purpose.

In the aqueous-phase solution method, a high purity product can be obtained. The LiCoVO_4 product from the aqueous-phase solution process does not contain any impurity (col. 7, lines 15 - 20 of Fey). This indicates that the process only produces a lithium transition metal oxide as a lithium intercalation compound. No other phase as a lithium ion conductor is

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observed. Therefore the product does not have a core and an outer layer structure. The LiNiVO_4 product has the similar feature of LiCoVO_4 without the core and outer layer structure.

Claims 4, 10 - 12, 16, 22, 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Fey as applied above in view of Yamaura et al. 5,626,635.

Yamaura et al. synthesize $\text{LiNi}_x\text{Co}_{1-x}\text{O}_2$ or $\text{LiNi}_x\text{Mn}_{1-x}\text{O}_2$ wherein the crystal structure is a single phase (col. 2, lines 50 - 56). This is different than applicant's product which has two phases. Therefore Yamaura et al. do not synthesize the materials with a core and an outer layer. Because applicant's $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ with more cobalt is more thermally stable with less capacity (W. Li, et al. J. Electrochem. Soc. vol. 144, 2773 (1997) in Table I and Figure 3), one important product for the present patent application is the $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ material with cobalt richer in the surface than in the core (page 7 lines 5 - 10; amended claim 10). Therefore conditions (5) and (6) are satisfied at the same time by applicant, and not by Yamaura et al.

Yamaura et al. do not teach or suggest that $\text{LiNi}_{1-x}\text{Co}_x\text{O}_2$ with more cobalt in the coating is more thermally stable. Figure 2 in Yamaura shows that $\text{LiNi}_x\text{Co}_{1-x}\text{O}_2$ with a cobalt content of 0.5 - 0.95 has about the same cycle stability and more cobalt in $\text{LiNi}_x\text{Co}_{1-x}\text{O}_2$ does not necessarily result in a lower capacity because 0.2 cobalt content ($x=0.8$) sample has a higher capacity than the 0.05 cobalt content ($x=0.95$) sample. Therefore, Yamaura et al. do not select core materials and a lithium ion conductor to produce applicant's product.

In summary, the principal reference Fey does not teach a process to produce a two-phase stable product having a core and an outer coating with increased electrode capacity. Yamaura et al. cited as a secondary reference, cannot be combined with Fey to arrive at applicant's claimed cathodic material. A

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It is believed that the claims as amended are clearly patentably distinguished over the cited references, taken alone or in combination, and their allowance is earnestly solicited.

Respectfully submitted,

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